

**U.S. ENVIRONMENTAL PROTECTION AGENCY  
NATIONAL AIR AND RADIATION ENVIRONMENTAL LABORATORY  
540 S. MORRIS AVE., MONTGOMERY, AL 36115  
TH ANALYSES**

**REPORT OF SAMPLE DELIVERY GROUP #1000029**

Project: Smokey Mountain Smelter, Knoxville, TN  
Analysis Procedure: Actinides (Thorium) by Extraction Chromatography  
Report ID: 1000029-TH  
Report Type: Original  
Date Reported: 11/18/2010  
Total Pages in Report: 21

**SAMPLES**

NAREL Sample #	Client Sample ID	Type	Matrix	Date Collected	Date Received
B0.07995U	03377 5-7 CM	SAM	SOIL	09/09/2010	09/17/2010
B0.07996V	03378 5-7 CM	SAM	SOIL	09/09/2010	09/17/2010
B0.07997W	03379 5-7 CM	SAM	SOIL	09/09/2010	09/17/2010
B0.07998X	03380 5-7 CM	SAM	SOIL	09/09/2010	09/17/2010
B0.07999Y	03381 5-7 CM	SAM	SOIL	09/09/2010	09/17/2010
B0.08000U	03045 5-7 CM	SAM	SOIL	09/09/2010	09/17/2010
B0.08001V	03046 5-7 CM	SAM	SOIL	09/09/2010	09/17/2010
B0.08002W	03047 5-7 CM	SAM	SOIL	09/09/2010	09/17/2010

**EXCEPTIONS**

1. Packaging and Shipping - No problems were observed.
2. Documentation - No problems were observed.
3. Sample Preparation - No problems were encountered.
4. Analysis - All samples in this SDG were reanalyzed for thorium due to a lab control sample QC failure. The LCS was acceptable on the reanalysis. The results of the reanalyses are reported in this data package.
5. Holding Times - All holding times were met.

**QUALITY CONTROL**

1. QC samples - All QC analysis results met NAREL acceptance criteria.
2. Yields - All chemical yields were within acceptance limits.
3. Instruments - Response and background checks for all instruments used in these analyses met NAREL acceptance criteria.

## CERTIFICATION

I certify that this data report complies with the terms and conditions of the Quality Assurance Project Plan, except as noted above. Release of the data contained in this report has been authorized by the Director of the Center for Environmental Radioanalytical Laboratory Science and the NAREL Quality Assurance Manager, or their designees, as verified by the following signatures.

Mary Wisdom  
Mary F. Wisdom  
Quality Assurance Manager, NAREL

11-29-10  
Date

John Griggs  
John G. Griggs, Ph.D.  
Director, Center for Environmental Radioanalytical  
Laboratory Science

11/30/10  
Date

## GENERAL INFORMATION

### SAMPLE TYPES

BLD	Blind sample
FBK	Field blank
SAM	Normal sample

### ANALYSIS QC TYPES

ANA	Normal analysis
DUP	Laboratory duplicate
LCS	Laboratory control sample (blank spike)
MS	Matrix spike
MSD	Matrix spike duplicate
RBK	Method blank

### QUALITY INDICATORS

RPD	Relative Percent Difference
%R	Percent Recovery
Z	Number of standard deviations by which a QC measurement differs from the expected value

### EVALUATION OF QC ANALYSES

A method blank result is considered unacceptable if it is more than 3 standard deviations below zero or more than 3 standard deviations above a predetermined upper control limit. For some analyses NAREL has set the upper control limit at zero. For others the control limit is a small positive number.

NAREL evaluates the results of duplicate and spike analyses using "Z scores." A Z score is the number of standard deviations by which the QC result differs from its ideal value. The score is considered acceptable if its absolute value is not greater than 3.

The Z score for a spiked sample is computed by dividing the difference between the measured value and the target value by the combined standard uncertainty of the difference.

The Z score for a duplicate analysis is computed by dividing the difference between the two measured values by the combined standard uncertainty of the difference. When the precision of paired MS/MSD analyses is evaluated, the native sample activity is subtracted from each measured value and the net concentrations are then converted to total activities before the Z score is computed.

Each standard uncertainty used to compute a Z score includes an additional fixed term to represent sources of measurement error other than counting error. This additional term is not used in the evaluation of reagent blanks.

NAREL reports the "relative percent difference," or RPD, between duplicate results and the "percent recovery," or %R, for spiked analyses, but does not use these values for evaluation.

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**SDG #1000029**

**ANALYSIS SUMMARY**

Analysis Procedure: NAREL TH-EICHROM  
Title: Actinides (Thorium) by Extraction Chromatography

NAREL Sample #	QC Type	Preparation Procedure	Date Completed	Assay Batch #	QC Batch #
B0.07995U		N/A	11/17/2010	0014561D	0007126K
B0.07996V		N/A	11/17/2010	0014561D	0007126K
B0.07997W		N/A	11/17/2010	0014561D	0007126K
B0.07998X		N/A	11/17/2010	0014561D	0007126K
B0.07999Y		N/A	11/17/2010	0014561D	0007126K
B0.08000U		N/A	11/17/2010	0014564G	0007126K
B0.08001V		N/A	11/17/2010	0014564G	0007126K
B0.08002W		N/A	11/17/2010	0014564G	0007126K
B0.08002W	DUP	N/A	11/17/2010	0014564G	0007126K
LCS-00594677R *	LCS	N/A	11/17/2010	0014564G	0007126K
RBK-00594676Q *	RBK	N/A	11/17/2010	0014561D	0007126K

\* Samples marked with an asterisk are not in this sample delivery group but were analyzed with it for QC purposes.

**PREPARATION METHOD(S) USED**

Procedure ID	Title

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**SDG #1000029**

**SAMPLE ANALYSIS REPORT**

Sample #:	B0.07995U	QC batch #:	0007126K
Matrix:	SOIL	Assay batch #:	0014561D
Sample type:	SAM	Prep procedure:	N/A
Amount analyzed:	2.512e-01 GASH	Analysis procedure:	NAREL TH-EICHROM
Dry/wet weight:	81.83 %	Analyst:	PMT
Ash/dry weight:	94.79 %	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

**COUNTING INFORMATION**

Date and time	Duration (min)	Detector ID	Operator
11/16/2010 16:38	1000.0	AS05	DPG

**ANALYTICAL RESULTS**

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Date
Th227	1.78e+00	3.7e-01	1.4e-01	PCI/GDRY	11/15/2010
Th228	8.16e-01	1.7e-01	7.8e-02	PCI/GDRY	11/15/2010
Th230	3.74e+01	2.8e+00	4.8e-02	PCI/GDRY	11/15/2010
Th232	7.78e-01	1.6e-01	4.8e-02	PCI/GDRY	11/15/2010

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**SDG #1000029**

**SAMPLE ANALYSIS REPORT**

Sample #:	B0.07996V	QC batch #:	0007126K
Matrix:	SOIL	Assay batch #:	0014561D
Sample type:	SAM	Prep procedure:	N/A
Amount analyzed:	2.519e-01 GASH	Analysis procedure:	NAREL TH-EICHROM
Dry/wet weight:	87.60 %	Analyst:	PMT
Ash/dry weight:	91.54 %	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

**COUNTING INFORMATION**

Date and time	Duration (min)	Detector ID	Operator
11/16/2010 16:37	1000.0	AS06	DPG

**ANALYTICAL RESULTS**

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Date
Th227	8.87e-01	2.5e-01	1.1e-01	PCI/GDRY	11/15/2010
Th228	1.13e+00	2.1e-01	9.6e-02	PCI/GDRY	11/15/2010
Th230	2.62e+01	2.0e+00	3.4e-02	PCI/GDRY	11/15/2010
Th232	1.05e+00	2.0e-01	5.1e-02	PCI/GDRY	11/15/2010

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**SDG #1000029**

**SAMPLE ANALYSIS REPORT**

Sample #:	B0.07997W	QC batch #:	0007126K
Matrix:	SOIL	Assay batch #:	0014561D
Sample type:	SAM	Prep procedure:	N/A
Amount analyzed:	2.502e-01 GASH	Analysis procedure:	NAREL TH-EICHROM
Dry/wet weight:	87.60 %	Analyst:	PMT
Ash/dry weight:	95.88 %	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

**COUNTING INFORMATION**

Date and time	Duration (min)	Detector ID	Operator
11/16/2010 16:38	1000.0	AS07	DPG

**ANALYTICAL RESULTS**

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Date
Th227	1.59e+00	3.6e-01	1.5e-01	PCI/GDRY	11/15/2010
Th228	8.20e-01	1.8e-01	1.0e-01	PCI/GDRY	11/15/2010
Th230	3.65e+01	2.8e+00	5.9e-02	PCI/GDRY	11/15/2010
Th232	7.97e-01	1.7e-01	6.3e-02	PCI/GDRY	11/15/2010

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**SAMPLE ANALYSIS REPORT**

Sample #:	B0.07998X	QC batch #:	0007126K
Matrix:	SOIL	Assay batch #:	0014561D
Sample type:	SAM	Prep procedure:	N/A
Amount analyzed:	2.509e-01 GASH	Analysis procedure:	NAREL TH-EICHROM
Dry/wet weight:	87.98 %	Analyst:	PMT
Ash/dry weight:	91.93 %	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

**COUNTING INFORMATION**

Date and time	Duration (min)	Detector ID	Operator
11/16/2010 16:38	1000.0	AS08	DPG

**ANALYTICAL RESULTS**

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Date
Th227	1.64e+00	3.6e-01	9.9e-02	PCI/GDRY	11/15/2010
Th228	7.59e-01	1.7e-01	1.1e-01	PCI/GDRY	11/15/2010
Th230	3.57e+01	3.9e+00	3.7e-02	PCI/GDRY	11/15/2010
Th232	8.15e-01	1.7e-01	3.7e-02	PCI/GDRY	11/15/2010



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**SDG #1000029**

**SAMPLE ANALYSIS REPORT**

Sample #:	B0.07999Y	QC batch #:	0007126K
Matrix:	SOIL	Assay batch #:	0014561D
Sample type:	SAM	Prep procedure:	N/A
Amount analyzed:	2.518e-01 GASH	Analysis procedure:	NAREL TH-EICHROM
Dry/wet weight:	79.17 %	Analyst:	PMT
Ash/dry weight:	84.96 %	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

**COUNTING INFORMATION**

Date and time	Duration (min)	Detector ID	Operator
11/16/2010 16:38	1000.0	AS09	DPG

**ANALYTICAL RESULTS**

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Date
Th227	9.14e-01	2.5e-01	7.7e-02	PCI/GDRY	11/15/2010
Th228	9.36e-01	1.8e-01	4.8e-02	PCI/GDRY	11/15/2010
Th230	1.55e+01	1.3e+00	3.2e-02	PCI/GDRY	11/15/2010
Th232	8.37e-01	1.7e-01	5.3e-02	PCI/GDRY	11/15/2010

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**SDG #1000029**

**SAMPLE ANALYSIS REPORT**

Sample #:	B0.08000U	QC batch #:	0007126K
Matrix:	SOIL	Assay batch #:	0014564G
Sample type:	SAM	Prep procedure:	N/A
Amount analyzed:	2.521e-01 GASH	Analysis procedure:	NAREL TH-EICHROM
Dry/wet weight:	77.42 %	Analyst:	PMT
Ash/dry weight:	87.80 %	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

**COUNTING INFORMATION**

Date and time	Duration (min)	Detector ID	Operator
11/16/2010 16:38	1000.0	AS02	DPG

**ANALYTICAL RESULTS**

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Date
Th227	6.06e-01	1.9e-01	8.6e-02	PCI/GDRY	11/16/2010
Th228	1.02e+00	1.9e-01	7.5e-02	PCI/GDRY	11/16/2010
Th230	1.27e+01	1.1e+00	3.2e-02	PCI/GDRY	11/16/2010
Th232	9.08e-01	1.8e-01	4.8e-02	PCI/GDRY	11/16/2010

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**SDG #1000029**

**SAMPLE ANALYSIS REPORT**

Sample #:	B0.08001V	QC batch #:	0007126K
Matrix:	SOIL	Assay batch #:	0014564G
Sample type:	SAM	Prep procedure:	N/A
Amount analyzed:	1.251e-01 GASH	Analysis procedure:	NAREL TH-EICHROM
Dry/wet weight:	79.44 %	Analyst:	PMT
Ash/dry weight:	84.28 %	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

**COUNTING INFORMATION**

Date and time	Duration (min)	Detector ID	Operator
11/16/2010 16:38	1000.0	AS19	DPG

**ANALYTICAL RESULTS**

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Date
Th227	3.44e-02	1.1e-01	2.1e-01	PCI/GDRY	11/16/2010
Th228	1.64e-01	1.3e-01	1.8e-01	PCI/GDRY	11/16/2010
Th230	1.64e-01	1.1e-01	1.2e-01	PCI/GDRY	11/16/2010
Th232	1.15e-01	8.7e-02	6.2e-02	PCI/GDRY	11/16/2010

**U.S. ENVIRONMENTAL PROTECTION AGENCY  
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**SDG #1000029**

**SAMPLE ANALYSIS REPORT**

Sample #:	B0.08002W	QC batch #:	0007126K
Matrix:	SOIL	Assay batch #:	0014564G
Sample type:	SAM	Prep procedure:	N/A
Amount analyzed:	2.544e-01 GASH	Analysis procedure:	NAREL TH-EICHROM
Dry/wet weight:	79.50 %	Analyst:	PMT
Ash/dry weight:	93.27 %	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

**COUNTING INFORMATION**

Date and time	Duration (min)	Detector ID	Operator
11/16/2010 16:38	1000.0	AS20	DPG

**ANALYTICAL RESULTS**

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Date
Th227	4.04e-02	8.0e-02	1.4e-01	PCI/GDRY	11/16/2010
Th228	9.59e-01	2.1e-01	1.4e-01	PCI/GDRY	11/16/2010
Th230	5.73e-01	1.5e-01	4.8e-02	PCI/GDRY	11/16/2010
Th232	1.23e+00	2.2e-01	5.5e-02	PCI/GDRY	11/16/2010

**U.S. ENVIRONMENTAL PROTECTION AGENCY  
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**SDG #1000029**

**SAMPLE ANALYSIS REPORT**

Sample #:	B0.08002W	QC batch #:	0007126K
Matrix:	SOIL	Assay batch #:	0014564G
Sample type:	SAM	Prep procedure:	N/A
Amount analyzed:	2.526e-01 GASH	Analysis procedure:	NAREL TH-EICHROM
Dry/wet weight:	79.50 %	Analyst:	PMT
Ash/dry weight:	93.27 %	QC type:	DUP
Sample description:	N/A		
Comment:	N/A		

**COUNTING INFORMATION**

Date and time	Duration (min)	Detector ID	Operator
11/16/2010 16:38	1000.0	AS29	DPG

**ANALYTICAL RESULTS**

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Date
Th227	9.22e-02	7.6e-02	9.2e-02	PCI/GDRY	11/16/2010
Th228	1.17e+00	1.9e-01	8.5e-02	PCI/GDRY	11/16/2010
Th230	8.14e-01	1.5e-01	3.5e-02	PCI/GDRY	11/16/2010
Th232	1.09e+00	1.8e-01	3.5e-02	PCI/GDRY	11/16/2010

**U.S. ENVIRONMENTAL PROTECTION AGENCY  
NATIONAL AIR AND RADIATION ENVIRONMENTAL LABORATORY**

**SDG #1000029**

**SAMPLE ANALYSIS REPORT**

Sample #:	LCS-00594677R	QC batch #:	0007126K
Matrix:	N/A	Assay batch #:	0014564G
Sample type:	N/A	Prep procedure:	N/A
Amount analyzed:	1.000e+00 SAMP	Analysis procedure:	NAREL TH-EICHROM
Dry/wet weight:	N/A	Analyst:	PMT
Ash/dry weight:	N/A	QC type:	LCS
Sample description:	N/A		
Comment:	N/A		

**COUNTING INFORMATION**

Date and time	Duration (min)	Detector ID	Operator
11/16/2010 16:38	1000.0	AS30	DPG

**ANALYTICAL RESULTS**

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Date
Th227	-3.77e-03	7.1e-03	2.2e-02	PCI	11/16/2010
Th228	1.47e-02	1.2e-02	1.5e-02	PCI	11/16/2010
Th230	2.45e+00	2.1e-01	9.0e-03	PCI	11/16/2010
Th232	1.26e-02	9.6e-03	6.8e-03	PCI	11/16/2010

**U.S.ENVIRONMENTAL PROTECTION AGENCY  
NATIONAL AIR AND RADIATION ENVIRONMENTAL LABORATORY**

**SDG #1000029**

**SAMPLE ANALYSIS REPORT**

Sample #:	RBK-00594676Q	QC batch #:	0007126K
Matrix:	N/A	Assay batch #:	0014561D
Sample type:	N/A	Prep procedure:	N/A
Amount analyzed:	1.000e+00 SAMP	Analysis procedure:	NAREL TH-EICHROM
Dry/wet weight:	N/A	Analyst:	PMT
Ash/dry weight:	N/A	QC type:	RBK
Sample description:	N/A		
Comment:	N/A		

**COUNTING INFORMATION**

Date and time	Duration (min)	Detector ID	Operator
11/16/2010 16:38	1000.0	AS10	DPG

**ANALYTICAL RESULTS**

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Date
Th227	0.00e+00	1.2e-02	2.8e-02	PCI	11/15/2010
Th228	1.33e-02	1.7e-02	2.7e-02	PCI	11/15/2010
Th230	7.68e-03	9.6e-03	1.2e-02	PCI	11/15/2010
Th232	1.39e-03	6.2e-03	1.2e-02	PCI	11/15/2010

**U.S. ENVIRONMENTAL PROTECTION AGENCY  
NATIONAL AIR AND RADIATION ENVIRONMENTAL LABORATORY**

**SDG 1000029**

**QC BATCH SUMMARY**

QC batch #: 0007126K  
Preparation procedure: N/A  
Analysis procedure: NAREL TH-EICHROM

NAREL Sample #	QC Type	Yield (%)	$\pm 2 \sigma$ Uncertainty (%)	Analyst
B0.07995U		102.98 %	5.76 %	PMT
B0.07996V		95.66 %	5.49 %	PMT
B0.07997W		96.58 %	5.56 %	PMT
B0.07998X		94.94 %	5.46 %	PMT
B0.07999Y		94.13 %	5.45 %	PMT
B0.08000U		95.86 %	5.83 %	PMT
B0.08001V		90.66 %	5.57 %	PMT
B0.08002W		84.58 %	5.15 %	PMT
B0.08002W	DUP	88.91 %	5.49 %	PMT
LCS-00594677R *	LCS	92.24 %	5.50 %	PMT
RBK-00594676Q *	RBK	95.82 %	5.46 %	PMT

\* Samples marked with an asterisk are not in this sample delivery group but were analyzed with it for QC purposes.



**National Air and Radiation Environmental Laboratory  
QC Batch Report**

QC Batch #: 0007126K

Analytical Procedure: NAREL TH-EICHROM

**METHOD BLANKS (PCI)**

Sample ID	Nuclide	Activity $\pm 2\sigma$	Prep Date	Flags
00594676Q	TH227	0.00e+00 $\pm$ 1.2e-02	2010-11-15	OK
00594676Q	TH228	1.33e-02 $\pm$ 1.7e-02	2010-11-15	OK
00594676Q	TH230	7.68e-03 $\pm$ 9.6e-03	2010-11-15	OK
00594676Q	TH232	1.39e-03 $\pm$ 6.2e-03	2010-11-15	OK

**LABORATORY DUPLICATES (PCI/GASH)**

Sample ID	Nuclide	Original $\pm 2\sigma$	Duplicate $\pm 2\sigma$	RPD	Z
B0.08002W	TH227	4.33e-02 $\pm$ 8.5e-02	9.88e-02 $\pm$ 8.2e-02	78.13	0.94 OK
B0.08002W	TH228	1.03e+00 $\pm$ 2.2e-01	1.25e+00 $\pm$ 2.1e-01	19.82	1.49 OK
B0.08002W	TH230	6.14e-01 $\pm$ 1.6e-01	8.73e-01 $\pm$ 1.7e-01	34.78	2.26 OK
B0.08002W	TH232	1.32e+00 $\pm$ 2.4e-01	1.17e+00 $\pm$ 2.0e-01	11.90	-0.95 OK

**LAB CONTROL SAMPLES (PCI)**

Sample ID	Nuclide	Amt Added $\pm 2\sigma$	Measured $\pm 2\sigma$	%R	Z
00594677R	TH227	NO SPIKE DATA			
00594677R	TH228	NO SPIKE DATA			
00594677R	TH230	2.54e+00 $\pm$ 2.2%	2.45e+00 $\pm$ 2.1e-01	96.66	-0.79 OK
00594677R	TH232	NO SPIKE DATA			

Analyst:

Paula Thaxton  
Thaxton, Paula M.

11/17/10

QA Officer:

Kim J. McEwan

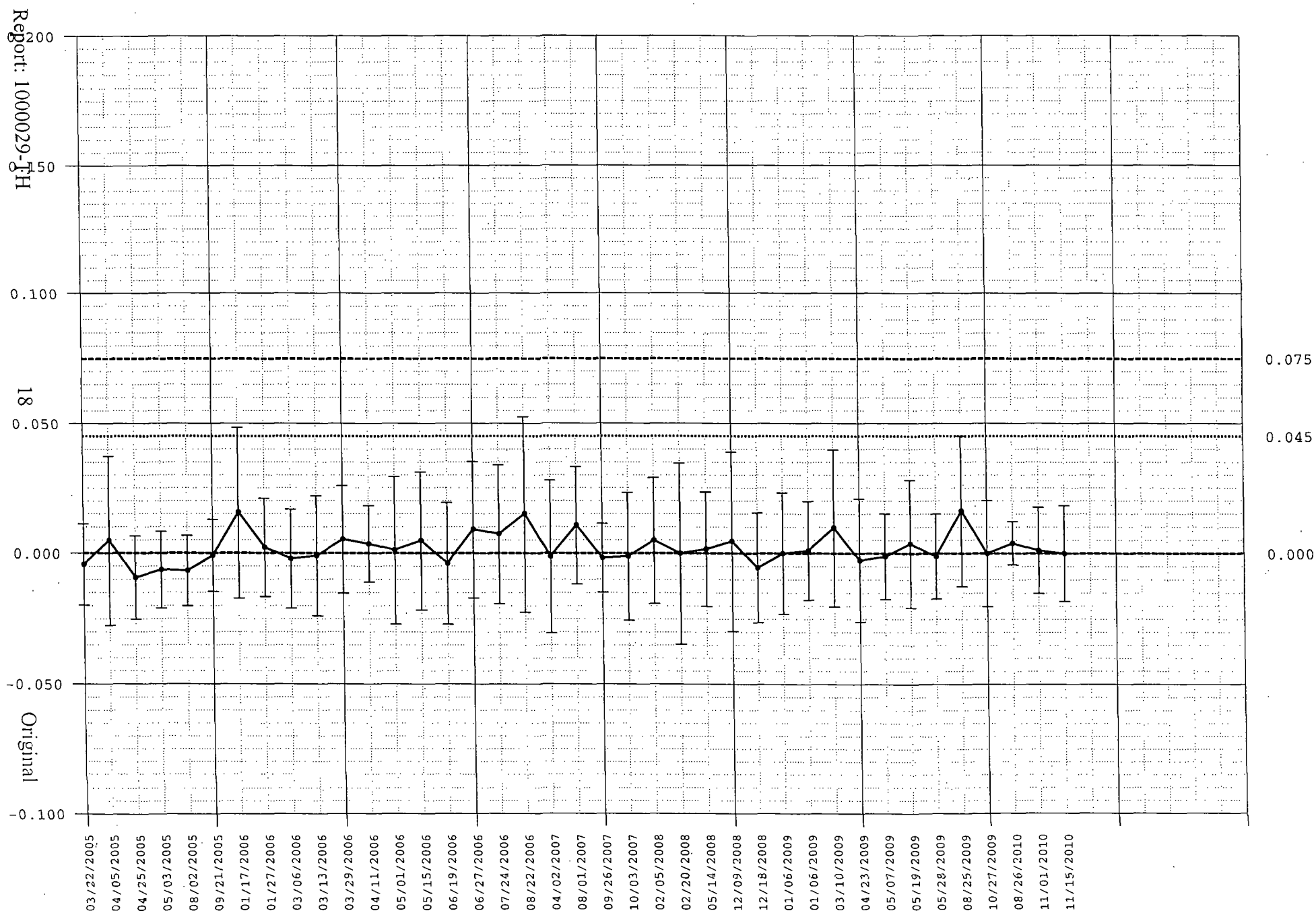
11/17/10

Method Blanks

Analyte: TH227

Method: NAREL TH-EICHROM

Analyst: Thaxton, Paula M.

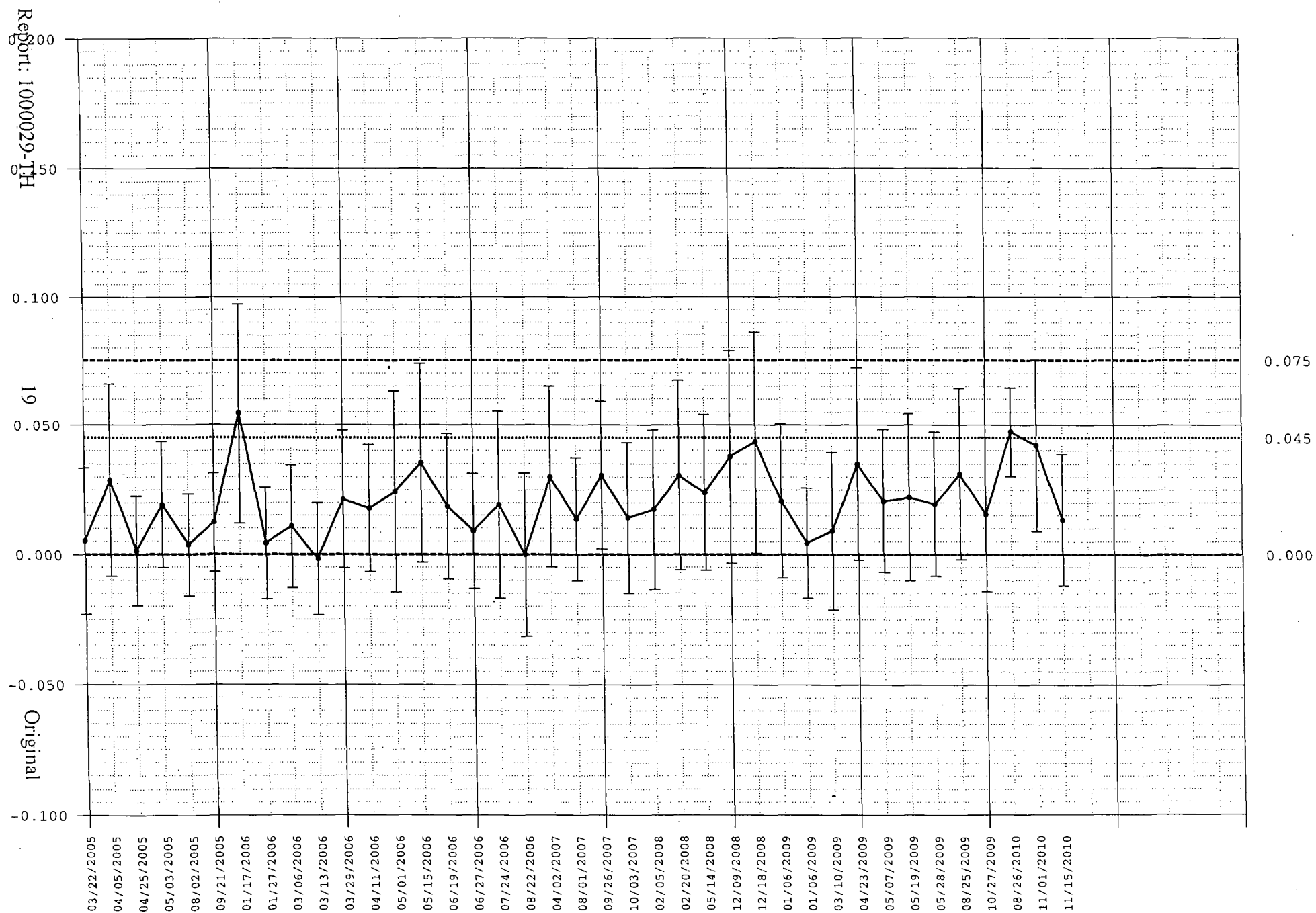


Method Blanks

Analyte: TH228

Method: NAREL TH-EICHROM

Analyst: Thaxton, Paula M.

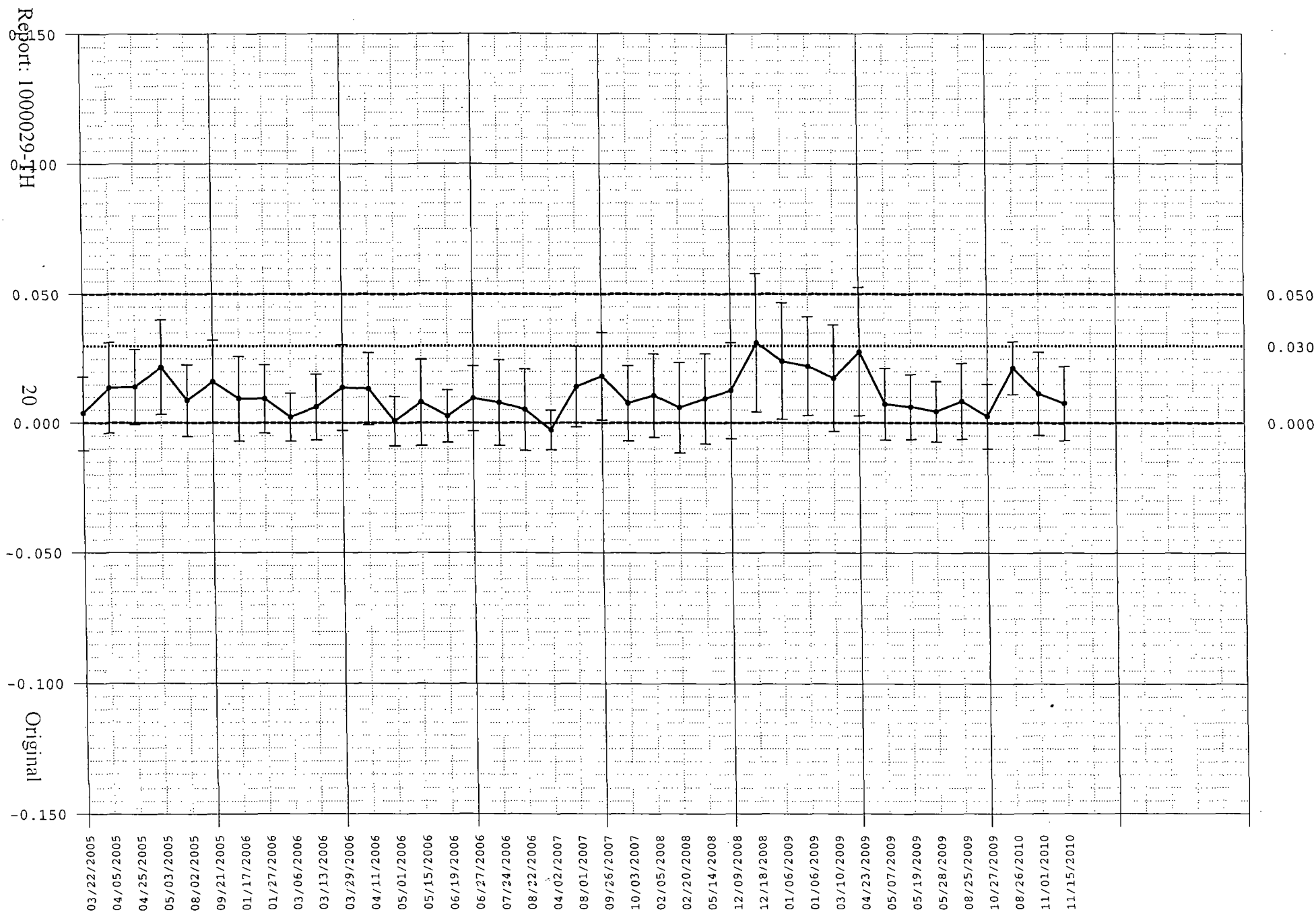


Method Blanks

Analyte: TH230

Method: NAREL TH-EICHROM

Analyst: Thaxton, Paula M.



Method Blanks

Analyte: TH232

Method: NAREL TH-EICHROM

Analyst: Thaxton, Paula M.

